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(12) # EUROPEAN PATENT APPLICATION

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(71) Applicant: **N.V. BEKAERT S.A.**
Bekaertstraat 2
B-8550 Zwevegem (BE)

(72) Inventor: **De Waegenaere, Johan**
Van Halewijnstraat 4
B-8550 Zwevegem (BE)
Inventor: **Sabbe, Luc**
Oliebergstraat 6
B-8540 Deerlijk (BE)
Inventor: **van Giel, Frans**
Nekkerplas 20
B-8560 Gullegem (BE)

(74) Representative: **Messely, Marc, Ir. et al**
N.V. Bekaert S.A.,
Bekaertstraat 2
B-8550 Zwevegem (BE)

(54) **Treatment of steel cord.**

(57) A steel cord (12) having steel filaments (2) twisted so as to have a final twist pitch, is subjected to

- a step (i) of plastically deforming the steel filaments (2) by overtwisting the steel cord (12) until a twist pitch which is smaller than the final twist pitch,
- a step (ii) of untwisting the steel cord (12) until the final twist pitch,
- a step (iii) of further untwisting the steel cord (12) until a twist pitch which is greater than the final twist pitch,
- a step (iv) of twisting the steel cord (12) again to its final twist pitch.

Steps (i) and (ii) are done under a first tension and steps (iii) and (iv) are done under a second tension, the second tension is lower than half the first tension.

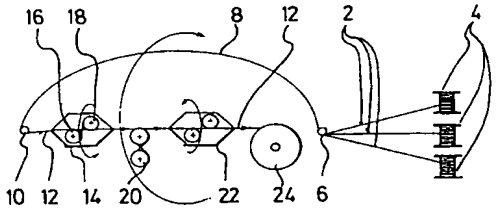

FIG.1

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The present invention relates to a process of treatment of a steel cord adapted for the reinforcement of rubber products, wherein the steel cord comprises steel filaments.

Steel cords are widely known and used for the reinforcement of rubber products such as tyres, conveyor belts, timing belts and hoses.

In order to fulfill their reinforcement function in a proper way, the steel cords must have a high tensile strength, a sufficient resistance to compression once embedded in rubber, a good fatigue and corrosion resistance, a sufficient adhesion to rubber and a high impact resistance.

Besides these 'first' properties, which all relate to the behaviour of steel cord in a rubber matrix, the rubber industry, and more particularly the tyre industry, requires other properties the steel cords must have. These other properties, in contradistinction with the first properties, all relate to the processability of the steel cords when handling the steel cords during the manufacture of e.g. tyres. Examples of these 'second' properties are absence of residual torsions, straightness, absence of flare, ...

Both the first and second properties are supposed to be fulfilled between narrow specified limits. It is a difficult task, if not a rather impossible one, for a cord manufacturer to meet all these requirements.

This task is thwarted by the fact that, during the entire process of manufacturing of a steel cord, the result of measures taken to meet one property is wholly or partially nullified by measures taken in order to meet another property in the downstream part of the process. The consequence is that a compromise must be sought or that one or more properties must be sacrified in favour of the other properties.

As a matter of a first example, part of the tensile strength of the steel filaments gets lost during the subsequent twisting process.

As a matter of a second example, part of the degree of preforming may be lost during the downstream false twisting or during the downstream straightening.

It is an object of the present invention to facilitate the meeting of some steel cord properties.

It is another object of the present invention to make the attainment of some steel cord properties independent of the attainment of other steel cord properties.

It is still another object of the present invention to provide for a process of manufacturing a high-elongation steel cord which has a controllable amount of residual torsions and which has a controllable openness and a sufficient and controllable elongation.

It is a further object of the present invention to provide for a process of manufacturing a steel cord which has a controllable amount of residual torsions and has a sufficient and controllable openness and a sufficient and controllable P.L.E. (part load elongation, for definition see below).

According to a first aspect of the present invention, there is provided a process of treatment of a steel cord adapted for the reinforcement of rubber products. The steel cord comprises steel filaments which have been twisted to a final twist pitch.

The process comprises

- a step (i) of plastically deforming the steel filaments by overtwisting the steel cord until a twist pitch which is smaller than the final twist pitch ;
- a step (ii) of untwisting the steel cord until the final twist pitch ;
- a step (iii) of further untwisting the steel cord until a twist pitch which is greater than the final twist pitch ;
- a step (iv) of twisting the steel cord again to its final twist pitch.

Steps (i) and (ii) are done under a first tension. Steps (iii) and (iv) are done under a second tension. The second tension is lower than half the first tension.

The terms 'process of treatment of a steel cord' do not necessarily mean that the process can only be carried out as a so-called post-treatment on an already finished steel cord. The terms 'process of treatment of a steel cord' also include processes of manufacturing a steel cord whereby the process comprises the above mentioned steps (i) to (iv) carried out on a set of steel filaments which have just been twisted or cabled in an upstream step.

Overtwisting the steel cord means twisting the steel cord until a twist pitch which is smaller than the twist pitch before overtwisting.

Plastically deforming the steel filaments by overtwisting the steel cord means that the degree of overtwisting is such that the steel filaments are deformed beyond their elastical limit. Plastically deforming the steel filaments by over-twisting may decrease the radius of curvature of the steel filaments in a controllable way. The higher the degree of overtwisting in the plastical region, the smaller the radius of curvature.

A small radius of curvature, if small enough, corresponds to an open cord structure, which allows rubber penetration even when the cord is put under a tensile tension of about twenty to fifty Newton. This openness at tensile torsions between twenty and fifty Newton may be quantified by a P.L.E.-value in the case of single-strand constructions of the type 1xn.

P.L.E. means part load elongation and is the elongation of the cord at a predetermined tensile tension between twenty and fifty Newton.

In the case of high-elongation steel cords, the degree of plastical deformation of the steel filaments determines to a large extent the total elongation at fracture of the steel cord.

The subsequent and downstream steps (iii) and (iv) are done in order to bring the number of residual torsions to zero or to a predetermined value.

The advantage of the present invention is that during the steps (iii) and (iv) the steel cord is not stretched in such a way that the small radius of curvature of the steel filaments is increased again. This is reached by untwisting the steel cord under a low tension, i.e. a tension which is less than half the overtwisting tension. In other words, the plastical deformation of the filaments is not substantially modified during the steps (iii) and (iv).

By way of an example, if the steel cord comprises two to five steel filaments having a filament diameter between 0.10 mm and 0.40 mm, the untwisting tension is lower than 25 Newton, preferably lower than 20 Newton or 15 Newton, e.g. about 10 Newton.

By way of another example, the steel cord may be a high-elongation cord. Such a cord comprises two to seven strands. Each strand comprises two to seven steel filaments with a filament diameter between 0.10 mm and 0.35 mm. The twisting direction of the filaments in a strand is equal to the twisting direction of the strands in the high-elongation cord. The elongation at break of a high-elongation cord conveniently ranges from 5 to 10 %.

The steps (i) and (ii) may be done by means of a first false twister. The rotational speed of the overtwister determines the degree of overtwisting, and consequently also the degree of plastically deforming the steel filaments.

Steps (iii) and (iv) may be done by means of a second false twister.

The rotational speed of the second false twister is conveniently smaller than the rotational speed of the first false twister.

As will be explained further in more detail, embodiments are possible where the second false twister rotates in the opposite sense as the first false twister as well as where the second false twister rotates in the same sense as the first false twister.

The process may include further steps of straightening the steel cord and/or of rolling the steel cord.

According to a second aspect of the present invention, there is provided for an apparatus for carrying out a treatment of a steel cord. The apparatus comprises following successive units :

(i) overtwisting means;

(ii) pull-through means;

(iii) untwisting means.

The pull-through means draws the steel cord through the complete apparatus. Upstream the pull-through means, the tension must be high enough to compensate for the friction exercised by the upstream part on the steel cord. Downstream the pull-through means, the tension may be lower, i.e. just high enough to compensate only for the friction exercised by the remaining downstream part of the apparatus on the steel cord.

The overtwisting means is a first false twister, the pull-though means a capstan, and the untwisting means a second false twister.

The invention will now be explained in more detail with reference to the accompanying drawings wherein

FIGURE 1 shows a schematic configuration of a first embodiment of the present invention;

FIGURE 2 shows a schematic configuration of a second embodiment of the present invention.

Starting from the right side of FIGURE 1, three steel filaments 2 are drawn from three bobbins 4 and are led to a double twister via a guiding pulley 6 where the filaments receive a first torsion. The twisted steel filaments 2 are further guided by means of a flyer 8 to a reversing pulley 10 where the filaments receive a second torsion. After the reversing pulley 10 the steel cord 12 has already obtained its final twist pitch.

The steel cord 12 passes through a first false twister 14 which overtwists the steel cord until a twist pitch which is smaller than the final twist pitch and which subsequently untwists the steel cord until its final twist pitch. The false twister 14 may comprise a pair of pulleys 16, 18 around which the steel cord 12 may be wrapped a number of times.

False twisters are known as such in the art. By way of example only, US-A-3,771,304 describes a false twister functioning as an overtwister.

In the zone immediately upstream the false twister 14 the twist pitch of the steel cord is decreased, i.e. the radius of curvature of the composing steel filaments 2 is decreased. If the speed of the false twister 14 is high enough with respect to the pull through speed of the steel cord 12, the steel filaments 2 are plastically deformed.

A capstan 20 functions as a drive unit and draws the steel cord 12 through the upstream parts of the apparatus. The tension upstream the capstan 20 is in the range 40 to 70 Newton, the tension downstream the capstan 20 is below half the tension upstream the capstan 20, and may be 10 to 20 Newton.

A second false twister 22 rotates in the opposite sense as the first false twister 14 and partially untwists the steel cord 12 further to a twist pitch greater than the final twist and subsequently

twists again the steel cord to its final twist pitch. This is done in order to reduce or to control the residual torsions.

As already mentioned hereabove, the untwisting tension is low. In fact, the untwisting tension needs only to be high enough to overcome the friction in the second false twister 22 and in the winding unit 24. This low tension avoids that the small radius of curvature of the plastically deformed steel filaments gets lost due to stretching.

Summarizing, the first false twister 14 functions as a controller of the openness, in the case of single-strand steel cords of the 1xn-type and, in the case of a high-elongation cord, as a controller of the elongation, while the second false twister 22 functions as a controller of the degree of residual torsions. Both function independently of each other thanks to the low tension level under which the second false twister is operating.

FIGURE 2 shows a schematic configuration of another embodiment of the present invention. Starting from the left side, four steel filaments 2 are drawn from the supply bobbins 4 and are guided to a false twister 14 which is a 'first' false twister in the sense as described hereabove. False twister 14 rotates with a rotational speed which is higher than twice the rotational speed of flyer 8 (the rotational speed of flyer 8 determines the final twist pitch). In this way, the steel cord 12 is overtwisted.

Capstan 20 draws the steel cord 12 through the upstream parts of the apparatus. The overtwisting tension upstream the capstan 20 is in the range 40 to 70 Newton, the tension down-stream the capstan 20 is below half the overtwisting tension, and may be in the range of 10 to 20 Newton.

The steel cord 12 is further led to still another false twister 22 which is a 'second' false twister in the sense as described hereabove. False twister 22 rotates in the same sense as false twister 14 but at a speed which is lower than the speed of false twister 14 and lower than twice the rotational speed of flyer 8. The result is that the steel cord 12 is partially untwisted.

The steel cord 12 is then led over a guiding pulley 6, a flyer 8, a reversing pulley 10, a straightener 26, a roller 28 and a capstan 30 to a winding up unit 24. The tension created by the capstan 28 needs only be high enough to compensate for the friction exercised by the parts of the apparatus which are downstream the first capstan 20 and is substantially lower than the tension created by the first capstan 20. Care must be exercised that the plastic deformation of the steel filaments 12 is not destroyed during the other downstream treatments such as rolling and/or straightening.

As in the embodiment of FIGURE 1, false twister 14 functions as a controller of the openness of the steel cord, in the case of single-strand construction of the type 1xn and, in the case of a high-elongation cord as a controller of the elongation, whereas false twister 22 functions as a controller of the residual torsions of the cord.

Claims

1. A process of treatment of a steel cord adapted for the reinforcement of rubber products,
said steel cord comprising steel filaments which have been twisted to a final twist pitch,
said process comprising
   - a step (i) of plastically deforming the steel filaments by overtwisting the steel cord until a twist pitch which is smaller than the final twist pitch,
   - a step (ii) of untwisting the steel cord until the final twist pitch,
   - a step (iii) of further untwisting the steel cord until a twist pitch which is greater than the final twist pitch,
   - a step (iv) of twisting the steel cord again to its final twist pitch,

   steps (i) and (ii) being done under a first tension and steps (iii) and (iv) being done under a second tension,
   the second tension being lower than half the first tension.

2. A process according to claim 1
wherein the steel cord comprises two to five steel filaments having a filament diameter between 0.10 mm and 0.40 mm.

3. A process according to claim 2
wherein the second tension is lower than 25 Newton.

4. A process according to claim 2
wherein the degree of overtwisting in step (i) is set to determine the final part load elongation of the steel cord.

5. A process according to claim 2
wherein the degree of further untwisting in step (iii) is set to determine the final number of residual torsions of the steel cord.

6. A process according to claim 1
wherein the steel cord is a high-elongation cord comprising two to seven strands, each strand comprising two to seven filaments with a filament diameter between 0.10 and 0.35 mm.

7. A process according to claim 6
wherein the degree of overtwisting in step (i) is set to determine the final elongation of the

steel cord.

8. A process according to claim 6 wherein the degree of further untwisting in step (iii) is set to determine the final number of residual torsions of the steel cord.

9. A process according to claim 1 wherein steps (i) and (ii) are done by means of a first false twister.

10. A process according to claim 9 wherein steps (iii) and (iv) are done by means of a second false twister.

11. A process according to claim 10 wherein the second false twister rotates in the other sense as the first false twister.

12. A process according to claim 11 wherein the second false twister rotates in the same sense as the first false twister.

13. A process according to claim 9 wherein the rotational speed of the second false twister is smaller than the rotational speed of the first false twister.

14. A process according to claim 1 wherein the process comprises a further step of straightening the steel cord.

15. A process according to claim 1 wherein the process comprises a further step of rolling the steel cord.

16. An apparatus for carrying out a treatment of a steel cord said apparatus comprising as successive units :
    (i) overtwisting means ;
    (ii) pull-through means ;
    (iii) untwisting means.

17. An apparatus according to claim 16 wherein the overtwisting means is a first false twister, the pull-through means is a capstan and the untwisting means is a second false twister.

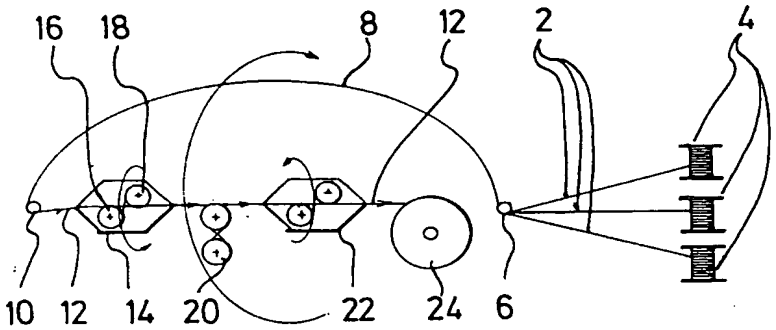

FIG. 1

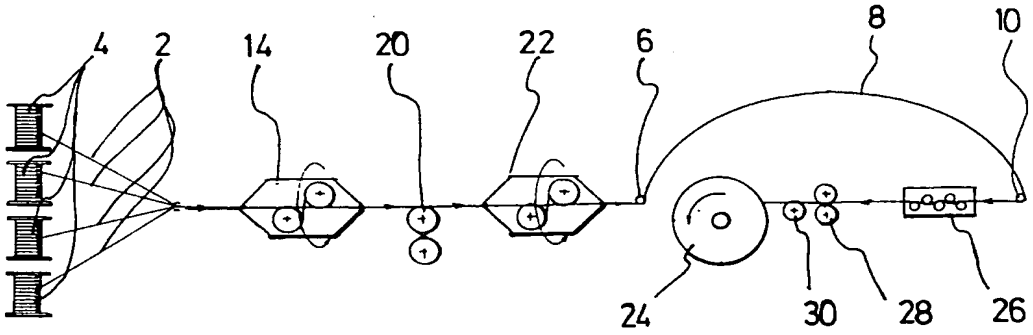

FIG. 2

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EUROPEAN SEARCH REPORT

Application Number
EP 94 20 0999

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.5)
A	GB-A-2 028 393 (SODETAL SOCIETE POUR LE DEVELOPPEMENT DU FIL METALLIQUE) * page 3, line 29 - line 54 *	1,9,14, 16,17	D07B3/10 D07B7/02
A	EP-A-0 063 054 (NATIONAL-STANDARD COMPANY) * page 3, line 7 - page 4, line 30 *	1,9,12, 15-17	
D,A	US-A-3 771 304 (K.TAKETOMI ET AL) * column 2, line 59 - column 3, line 34; figure 1 *	1,2,9, 16,17	
			TECHNICAL FIELDS SEARCHED (Int.Cl.5) D07B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	11 July 1994	Goodall, C

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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